FIG. **5** illustrates exemplary current versus time recovery characteristics **500**, in accordance with embodiments of the present invention. Recovery characteristic **510** represents reverse recovery characteristics of an exemplary 600 volt ultrafast diode as known in the conventional art. It is appreciated that the recovery characteristic comprises about three amperes of maximum reverse current and a duration of about 3×10 seconds.

Recovery characteristic **520** represents reverse recovery characteristics of an exemplary 600 volt diode, in accordance with embodiments of the present invention. It is to be appreciated that the recovery characteristic of this diode comprises significantly less current than the conventional diode of characteristic **510**. Recovery characteristic **520** shows a maximum reverse current of about 1.3 amps. Beneficially, the recovery duration is somewhat longer in duration than that of characteristic **510**, e.g., about 4.5×108 seconds.

Recovery characteristic **530** represents reverse recovery characteristics of a second exemplary 600 volt diode, in accordance with embodiments of the present invention. It is to be appreciated that the recovery characteristic of this diode comprises significantly less current than the conventional diode of characteristic **510**. Recovery characteristic **520** shows a maximum reverse current of about 0.8 amps. Beneficially, the recovery duration is somewhat longer in duration than that of characteristic **510**, e.g., about 4.5×108 seconds.

Accordingly, various embodiments of the present invention disclose an apparatus and method for a fast recovery rectifier structure. Embodiments of the present invention are able to reduce the reverse recovery charge while maintaining a soft recovery characteristic. Also, embodiments of the present invention disclose a silicon based fast recovery diode involving the creation of Schottky diode regions in series with JFET channel regions, or a merged PiN Schottky (MPS) diode structure. The MPS diode structure enables a higher Schottky to PiN ratio because of smaller geometries, and reduced channel resistance due to N doping between the well regions that reduce the contribution of hole injection during forward conduction, for example in one embodiment.

While the methods of embodiments illustrated in flow chart **400** show specific sequences and quantity of steps, the present invention is suitable to alternative embodiments. For example, not all the steps provided for in the methods are required for the present invention. Furthermore, additional steps can be added to the steps presented in the present embodiment. Likewise, the sequences of steps can be modified depending upon the application.

Embodiments of the present invention, a fast recovery rectifier structure having Schottky to PiN ratios approximately greater than or equal to one, and a method of fabricating the same are thus described. While the present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

What is claimed is:

1. A rectifier device, comprising

a substrate, wherein said substrate is doped with a first dopant type;

a first epitaxial layer doped with said first dopant type coupled to said substrate;

a first metallization layer adjacent to said first epitaxial layer;

a plurality of trenches recessed into said first epitaxial layer, wherein each of said plurality of trenches includes a conductive material coupled to said metallization layer;

a plurality of wells each doped with a second dopant type, wherein each of said plurality of wells is separated from one another, and wherein each of said plurality of wells is formed beneath a corresponding trench in said plurality of trenches;

a conductive layer disposed between each of the plurality of wells and the corresponding trench;

a plurality of oxide layers, each of which is formed on walls and a bottom of a corresponding trench such that a corresponding well is electrically isolated from said conductive material within said corresponding trench; and

a plurality of channel regions doped with said first dopant type formed within said first epitaxial layer, wherein each of said plurality of channel regions is located between two corresponding wells from said plurality of wells, and wherein each of said plurality of channel regions is more highly doped with said first dopant type than said first epitaxial layer.

2. The rectifier device of claim **1**, further comprising:

a second epitaxial layer located between said substrate said first epitaxial layer, wherein said second epitaxial layer is less highly doped than said substrate, and more highly doped than said first epitaxial layer.

3. The rectifier device of claim **1**, further comprising:

a Schottky barrier disposed under said first metallization layer, such that said Schottky barrier separates said first metallization layer and said first epitaxial layer.

4. The rectifier device of claim **3**, further comprising:

a plurality of PiN areas, wherein a ratio of area of said Schottky barrier to each of said plurality of PiN areas is approximately greater than or equal to one.

5. The rectifier device of claim **1**, wherein each of said plurality of trenches comprises undoped silicon.

6. The rectifier device of claim **1**, wherein said first dopant type comprises an n-type dopant.

7. The rectifier device of claim **1**, further comprising:

a plurality of remotely located contact regions coupled to said plurality of wells and said first metallization layer, wherein each of the remotely located contact regions is configured to couple a respective subset of the plurality of wells and the first metallization layer.

8. The rectifier device of claim **1**, wherein the conductive layer is a titanium silicide (TiSi2) layer.

9. An ultrafast diode, comprising:

a substrate, wherein said substrate is doped with a first dopant type;

a first epitaxial layer lightly doped with said first dopant type coupled to said substrate;

a first metallization layer adjacent to said first epitaxial layer;

a first trench recessed into said first epitaxial layer and including a first conductive material coupled to said metallization layer;

a first well doped with a second dopant type formed beneath said first trench;

a second trench recessed into said first epitaxial layer and including a second conductive material coupled to said metallization layer;

a second well doped with said second dopant type formed beneath said second trench;

a conductive layer disposed between each of the first and second wells and the corresponding trench; and

a channel region formed within said first epitaxial layer and located between said first well and said second well, wherein said channel region is more highly doped with said first dopant type than said first epitaxial layer.